curvature and postulate that reducing this angle, i.e. flaring the connection site, will reduce power losses.

1043-60 Validation of the Conductance Catheter in the Right Ventricle in Hypoplastic Left Heart Syndrome

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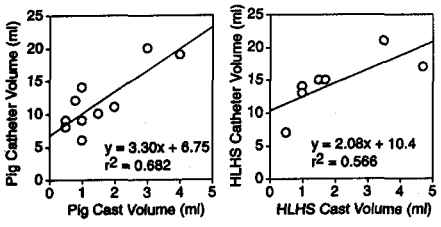
To date, the conductance catheter has primarily been used for left ventricular (LV) volume assessment because the volume calculations make assumptions regarding the behavior of the electrical field in an elliptical chamber. Given that ventricles in hearts with only one functioning chamber tend to be more spherical, irrespective of ventricular morphology, we hypothesized that volumes measured using the catheter would correlate linearly to true ventricular volumes in these hearts. We measured LV volumes in fixed normal pig heart specimens (n = 10) and right ventricular (RV) volumes in human heart specimens from patients with hypoplastic left heart syndrome (HLHS) (n = 7). While the hearts were submerged in saline, volumes were measured with a conductance catheter and correlated to volumes of silicon casts. Linear regression analysis determine correlation between the two volume measurement techniques. Volumes in pig hearts determined by the catheter correlated with cast volumes $p < 0.01$. In specimens with HLHS, catheter volumes also correlated with cast volumes $p = 0.05$. This study confirmed that volumes obtained using the conductance catheter correlate with LV volumes. RV volumes obtained with the conductance catheter in HLHS are also linearly related to cast volumes.



Therefore this method of volume measurement can be used to derive indices of ventricular function using pressure-volume relationships in these hearts. Further studies of human hearts with functional single ventricles are needed.

1043-61 Developmental Changes in Ventricular-Vascular Coupling in Piglets

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Previous work has suggested that in newborns, ventricular contractility is at or near maximum in order to maintain adequate cardiac output to meet metabolic demands. We wished to determine the relationship of contractility to afterload in newborn piglets to determine if afterload contributes to the high level of resting contractility. Under anesthesia, 1 and 6 week old piglets underwent cardiac catheterization using manometric and conductance catheters to record simultaneous pressures and volumes at rest and during isoproterenol (ISO) infusions (0.05, 0.1, 0.2, 0.3, 0.5, 0.75, and 1.0 μg/kg/min). End-systolic elastance (Ees) and arterial elastance (Ea) were measured from the pressure-volume data, and the ration Ea/Ees was calculated. ANOVA and multiple linear regression were used for analysis; $p < 0.05$ was significant. In 1 week olds, Ees fell slightly during ISO infusion (59.2 ± 22 at rest to 41.4 ± 9.7 at 1.0 μg/kg/min of ISO, $p < 0.05$), whereas in 6 week olds Ees increased significantly (14.2 ± 6.5 at rest to 29.1 ± 13 at 0.1 μg/kg/min ISO, $p < 0.05$). Ea fell in 1 week olds from 67.9 ± 13 at rest to 38.1 ± 13 at 1.0 μg/kg/min of ISO, but Ea did not change with ISO in 6 week olds (29.5 ± 12 at rest). Resting Ea was significantly higher in 1 week olds than in 6 week olds ($p < 0.05$). In 1 week olds, the ratio Ea/Ees was approximately equal to 1 at rest and did not change significantly on ISO; a significant decrease in Ea/Ees occurred in 6 week olds (2.3 ± 1.0 at rest to 0.83 ± 0.2 on 0.2 μg/kg/min ISO, $p < 0.05$). These findings suggest that contractile reserve, as measured by Ees, is limited in 1 week old piglets. Additionally, resting afterload as measured by Ea is relatively high in 1 week olds and falls by 6 weeks of age. Resting contractility may be higher in newborns to compensate for the relatively high resting afterload. Since external stroke work is optimal when the Ea/Ees ratio is 1, newborn piglets exhibit optimal ventricular-vascular coupling in order to maintain adequate cardiac output.

1043-62 Limitation of End-Systolic Elastance in Evaluation of Contractile Function in Piglets

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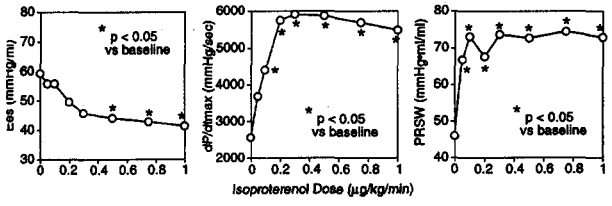
End-systolic elastance (Ees) has been suggested as a good index of contractility because of relative load insensitivity, but it is also known to be somewhat insensitive to changes in contractility. We wished to compare Ees to other indices of contractility to determine whether Ees was useful for evaluation of changes in systolic function in young piglets. Seven 1-wk-old piglets underwent cardiac catheterization for evaluation of left ventricular contractility. Ventricular pressures and volumes were measured using manometric and conductance catheters. Ees, dP/dtmax, and preload-recruitable stroke work (PRSW) were used to evaluate contractility at rest and in response to graded infusions (0.05. 0.1, 0.2, 0.3, 0.5, 0.75 and 1.0 μg/kg/min) of isoproterenol (ISO). Ees fell from values at rest during ISO infusions of 0.5 μg/kg/min and higher, while PRSW and dP/dtmax significantly increased from baseline at nearly all infusion rates.



We conclude that although Ees is at or near maximum at rest in 1 week olds, other indices of contractile function demonstrate evidence of contractile reserve. In addition, since Ees, dP/dtmax, and PRSW measure different parts of systole, one index alone may not be sufficient to completely evaluate contractile function. Finally, Ees may not be an ideal index for detecting minor changes in contractility in very young piglets, particularly when afterload simultaneously changes.

1043-63 LV Dysfunction after Open Repair of Simple Defects in Infants and Children: Quantitation With a Conductance Catheter After Bypass

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Difficulty in quantifying post-operative LV dysfunction has hampered its investigation and therapy. Optimal measurement of LV function during the perioperative period, with its dramatic changes in loading conditions, requires the use of load-independent indices of systolic and diastolic function e.g end-systolic (Ees) and end-diastolic (Eed) elastance. In 13 patients (11 ASD, 1 double-chambered RV, 1 supravalvarAS, age 0.25–14.4 years, weight 3.1–46.4 kg) LV function was measured from real-time pressure-volume loops using conductance and microtip pressure catheters placed in the long-axis via the LV apex. Basal dp/dt_{max}, dp/dt_{min}, time constant of isovolumic relaxation (τ), and Ees and Eed (during IVC snaring) were measured before and 10 min post-bypass. Mean bypass time was 41 ± 14 min, mean crossclamp time 27 ± 11 min.

Results:

	Pre-bypass	Post-bypass	% Change
Ees (mmHg/ml/kg)	0.34 ± 0.17	0.21 ± 0.15	−40.7 ($p < 001$)
Eed (mmHg/ml/kg)	29.26 ± 46.94	46.34 ± 94.41	58.0 ($p < 0.05$)
dp/dt_{max} (mmHg/sec)	1072 ± 426	1171 ± 380	35.0 ($p = 0.07$)
dp/dt_{min} (mmHg/sec)	724 ± 373	775 ± 334	40.8 ($p = 0.36$)
τ (sec^{-1})	45.0 ± 18.0	45.0 ± 13.0	10.7 ($p = 0.08$)

Conclusion: This is the first study to demonstrate the utility of a conductance catheter technique, in children, for the assessment of perioperative LV pressure-volume relationships. Incomplete myocardial protection was demonstrated by a deterioration in systolic and diastolic function after even short bypass and crossclamp times.

1043-64 Inhibition of Glycolysis Impairs Ventricular Relaxation But Not Peak Systolic Pressure in Neonatal Pig Hearts

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Myocardial relaxation is energy dependent, requiring ATP for the uptake of Ca^{2+} by the sarcoplasmic reticulum. We hypothesized that, in neonatal hearts, glycolysis is the major source of this ATP. Isolated, ventricularly-